Fingerprinting Building Spaces for Indoor Navigation

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Introduction

Problems

- Using image to identify one room can have various approaches, but not all efficient.
- Can human partnership improve and simplify the algorithm operated by computers?

Assumptions

- When entering a room, human observe the entire room and gather as much information as possible. Next time when we come back, we only need a certain view (or some features) to identify where we are within a building
- There are a convergence of the data collecting behavior

Project Goals

- Develop a system that can identify the user's location based on the photos taken by user
- The new system can distinguish one room from the other with high accuracy and the algorithm should be intuitive
- Understand what features are important to human and how human recognize intra-building areas

Figure 1: Classroom 317 In Dreese Lab

Figure 2: Classroom 357 in Dreese Lab

Current Methods

- The user decides what are the features within a room and use his/her smartphone to take a photo of the features
- The user uploads the image to the system, and the system will return the location of the room

System Architecture

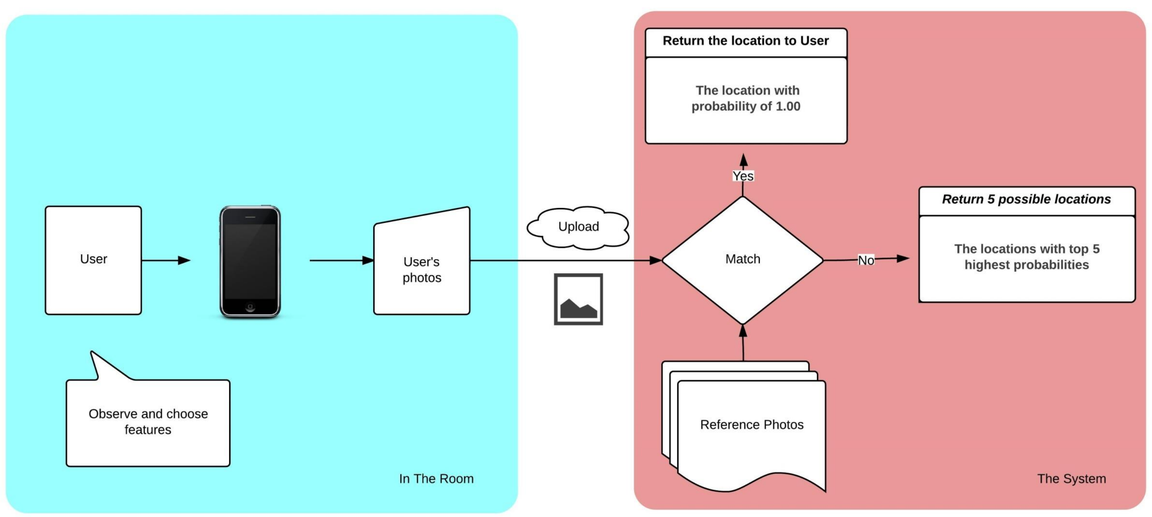

Figure 3: System Architecture Diagram

- The System return the location to user after five successful matches. If non of the reference photo from database can match five times, it will return the five most possible results to the user.
- The idea of the fingerprint is similar to the concept of human face recognition. If we want a person's friends to recognize this person, the most effective and efficient approach is to take a picture of the person's face. The human face contains most unique visual features. We can recognize one person from the other based on their faces immediately and intuitively without knowing exactly what the features are

Figure 4: The correspondence of human faces with room views

Feature Extraction and Matching

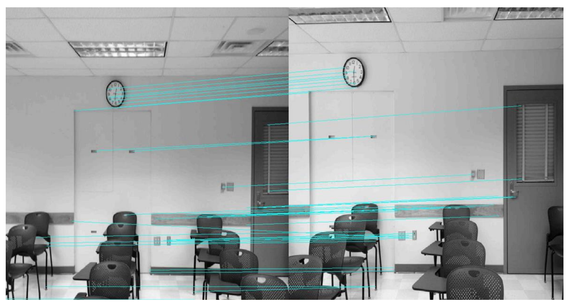

Figure 5: Single Image Matching

- We match the user's photo to the reference photo
- Based on the number of keypoints, we can make a threshold to determine the matching is successful or not

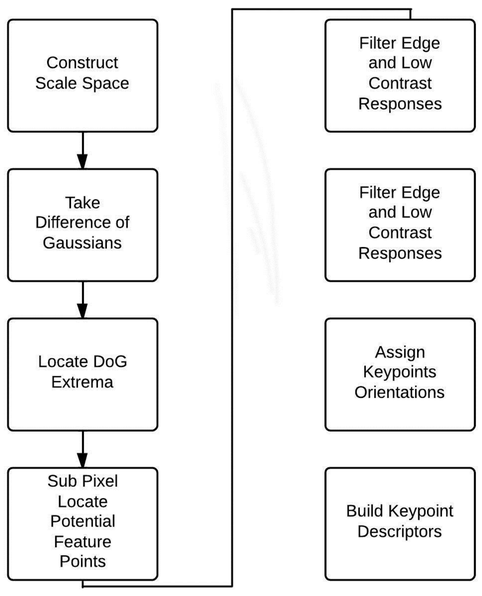

Figure 7: SIFT Features

- SIFT (Scale-invariant feature transform) creates keypoints that are invariant to scale, rotation and view angle
- The SIFT keypoints are reliable and accurate in identifying intra-building areas

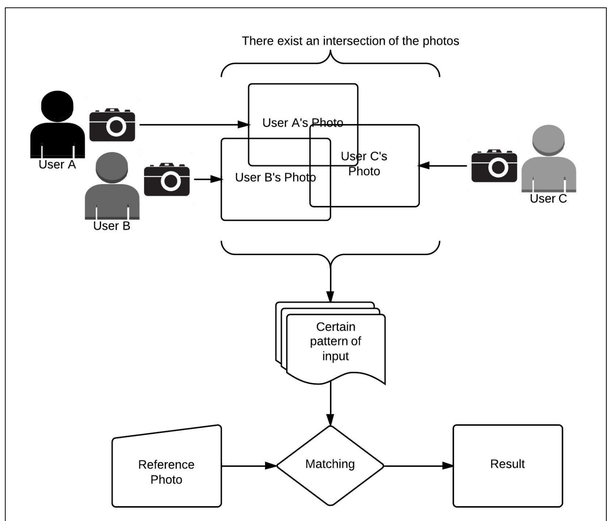

Figure 6: User Participation

- Show human participation can reduce the complexity of the input
- Without giving the user strict constraints, we expect the user to take the input photos in a certain pattern
- For example: Users tend to take the view with the blackboard in a classroom to be the featured image of the room.

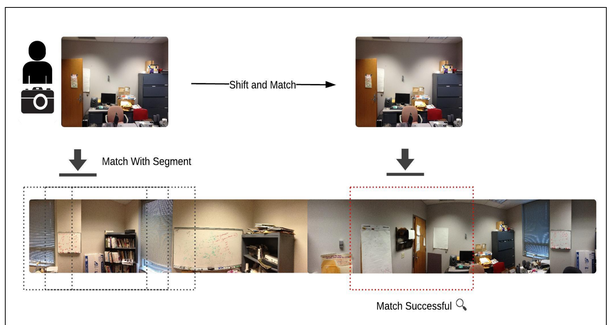

Figure 8: Scan matching

- The panorama is the reference photo which represents the information of every view of the room
- We scan and match the input image to each segment of the reference image

Significance

- The advantage of human participating in the algorithm can significantly improve the efficiency of the matching process because it simplifies the input data
- The system can apply to the use of indoor guide map or navigation which is valuable for guests who visit school buildings or commercial buildings

Future Work

Architecture

- Optimize the matching process.
- Optimize the architecture for system compatibility

Improvement

- Improve the user interface to be user-friendly and intuitive
- Enlarge the number of testing users to obtain more reliable results
- Improve the system to match images faster and more accurate

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